CLAIMS

1. A direct-current motor, comprising;

an armature core, wherein the core has a plurality of teeth, the teeth being arranged at a pitch of a first predetermined angle;

a plurality of armature coils, wherein each coli is wound about a different group of teeth having a predetermined number of teeth, wherein each tooth is located at the most advancing position in the rotation direction in one of the teeth groups, and wherein the armature core and the armature coils form an armature;

a plurality of magnets, wherein the magnets face one another with the armature in between, wherein each magnet includes:

a main portion;

an extended portion extending from the main portion;

a first weak flux part, which is located in the vicinity of the border of the extended portion and the main portion, wherein the first weak flux part extends along one pitch of the teeth, and the flux of the first weak flux part gradually increases along the rotation direction of the armature;

a commutator, which has a plurality of segments, wherein the segments are connected to each coil;

a pair of brushes, which can contact each segment, wherein the brushes supply current to the coils through the segments, wherein, during commutation, each brush establishes a short circuit in an adjacent pair of the commutator segments, thereby changing the direction of current flowing through the coil; and

wherein, when commutation is started for a group of teeth, the advancing end of the first tooth in that teeth group, the first tooth being located at the most advanced

position in the group in the rotation direction of the armature, is aligned with the first weak flux part of one of the magnets.

2. The direct-current motor according to claim 1, wherein the number of teeth belonging to the same group is represented by n, wherein the circumferential length of the main portion of each magnet corresponds to a second predetermined angle, wherein the second predetermined angle is determined such that, when the circumferential center of the first tooth is aligned with the most advancing portion of the main portion in the rotation direction of the armature, the most trailing end of the main portion in the rotation direction of the armature is circumferentially located between the nth tooth and (n-1)th tooth.

3. The direct-current motor according to claim 1, wherein the main portion of each magnet includes a second weak flux part, wherein the second weak flux part is spaced from the first weak flux part by an angle that corresponds to the first predetermined angle multiplied by an integer, and wherein the flux of the second weak flux part increases in a direction opposite to the rotation direction of the armature.

4. The direct-current motor according to claim 3, wherein the second weak flux part comprises a plurality of second weak flux parts, and wherein the second weak flux parts are located in the main portion of each magnet.

5. The direct-current motor according to claim 3, wherein the first weak flux part and the second weak flux part are formed by removing part of the inner surface of the main portion of each magnet.

6. The direct-current motor according to claim 5, wherein

the volume of part removed for forming the second weak flux part is equal to the volume of part removed for forming the first weak flux part.

7. The direct-current motor according to claim 1, wherein the number of teeth belonging to the same group is represented by n, wherein the circumferential length of the main portion of each magnet corresponds to a second predetermined angle, wherein the second predetermined angle is determined such that, when the circumferential center of the first tooth is aligned with the most advancing portion of the main portion in the rotation direction of the armature, the most trailing end of the main portion in the rotation direction of the armature is aligned with the advancing end of the nth tooth in the rotation direction of the armature.

8. The direct-current motor according claim 1, wherein the number of teeth belonging to the same group is represented by n, wherein the circumferential length of the main portion of each magnet corresponds to a second predetermined angle, wherein the second predetermined angle is determined such that, when the circumferential center of the first tooth is aligned with the most advancing portion of the main portion in the rotation direction of the armature, the most trailing end of the main portion in the rotation direction of the armature is aligned with the trailing end of the (n-1)th tooth in the rotation direction of the armature.

9. The direct-current motor according to claim 1, wherein the pitch of the segments is equal to the pitch of the teeth, and wherein an angle that corresponds to the contacting width between each brush and each segment is equal to the pitch of the teeth.

10. The direct-current motor according to claim 1, wherein

the number of the magnets is two, and wherein the magnets are symmetric with respect to the axis of the armature.

11. The direct-current motor according to claim 1, wherein the first weak flux part is formed by removing part of the outer surface of the main portion of each magnet.

12. A direct-current motor, comprising;

an armature core, wherein the core has a plurality of teeth, the teeth being arranged at a pitch of a first predetermined angle;

a plurality of armature coils, wherein each coli is wound about a different group of teeth having a predetermined number of teeth, wherein each tooth is located at the most advancing position in the rotation direction in one of the teeth groups, and wherein the armature core and the armature coils form an armature;

a plurality of magnets, wherein the magnets face one another with the armature in between, wherein each magnet includes:

a main portion;

an extended portion extending from the main portion;

a first weak flux part, which is located in the vicinity of the border of the extended portion and the main portion, wherein the first weak flux part extends along one pitch of the teeth, and the flux of the first weak flux part gradually increases along the rotation direction of the armature;

a commutator, which has a plurality of segments, wherein the segments are connected to each coil;

a pair of brushes, which can contact each segment, wherein the brushes supply current to the coils through the segments, wherein, during commutation, each brush establishes a short circuit in an adjacent pair of the commutator

segments, thereby changing the direction of current flowing through the coil; and

wherein the number of teeth belonging to the same group is represented by n, and wherein the position of each brush is determined such that, when the first tooth in one of the teeth groups, the first tooth being located at the most advanced position in the group in the rotation direction of the armature, is aligned with the first weak flux part of one of the magnets, the brush starts establishing a short circuit in an adjacent pair of segments that connects the coil.

13. A direct-current motor, comprising;

an armature core, wherein the core has a plurality of teeth, the teeth being arranged at a pitch of a first predetermined angle;

a plurality of armature coils, wherein each coli is wound about a different group of teeth having a predetermined number of teeth, wherein each tooth is located at the most advancing position in the rotation direction in one of the teeth groups, and wherein the armature core and the armature coils form an armature;

a pair of magnets, wherein the magnets face each other with the armature in between, wherein each magnet includes:

a main portion, wherein the circumferential length of the main portion corresponds to a second predetermined angle, wherein the number of teeth belonging to the same group is represented by n, and wherein, when the circumferential center of the first tooth in the group is aligned with the most advancing portion of the main portion in the rotation direction of the armature, the most trailing end of the main portion in the rotation direction of the armature is circumferentially located between the nth tooth and (n-1)th tooth;

an extended portion extending from the main portion;

a first weak flux part, which is located in the vicinity of the border of the extended portion and the main portion, wherein the first weak flux part extends along one pitch of the teeth, and the flux of the first weak flux part gradually increases along the rotation direction of the armature;

a commutator, which has a plurality of segments, wherein the segments are connected to each coil;

a pair of brushes, which can contact each segment, wherein the brushes supply current to the coils through the segments, wherein, during commutation, each brush establishes a short circuit in an adjacent pair of the commutator segments, thereby changing the direction of current flowing through the coil; and

wherein, when commutation is started for a group of teeth, the advancing end of the first tooth in that teeth group is aligned with the first weak flux part of one of the magnets.

14. The direct-current motor according to claim 13, wherein the main portion of each magnet includes a second weak flux part, wherein the second weak flux part is spaced from the first weak flux part by an angle that corresponds to the first predetermined angle multiplied by an integer, and wherein the flux of the second weak flux part increases in a direction opposite to the rotation direction of the armature.

15. The direct-current motor according to claim 14, wherein the second weak flux part comprises a plurality of second weak flux parts, and wherein the second weak flux parts are located in the main portion of each magnet.

16. The direct-current motor according to claim 15, wherein the first weak flux part and the second weak flux part are formed by removing part of the inner surface of the main

portion of each magnet.

17. The direct-current motor according to claim 13, wherein the pitch of the segments is equal to the pitch of the teeth, and wherein an angle that corresponds to the contacting width between each brush and each segment is equal to the pitch of the teeth.